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(54) Title: A METHOD AND APPARATUS FOR DETERMINING THE TOPOGRAPHICAL SURFACE SHAPE OF AN ARTICLE

(57) Abstract

Apparatus (1) for determining the topographical surface shape of a bulk meat product (2) comprises an infeed conveyor (7) in which the length of the bulk meat product (2) is determined. A weighing conveyor (9) weighs the bulk meat product (2), which is then transferred to a throughfeed conveyor (10) for passing the bulk meat product (2) through a scanning device (11) for scanning the circumferential surface of the bulk meat product (2) through 360° transversely of the direction of movement (arrow A) of the bulk meat product (2) through the scanning device (11). The scanning device (11) comprises a hoop-shaped carrier (43) on which four ultrasonic scanning heads (45) are mounted at 90° intervals to each other. A stepper motor (47) rotates the carrier (43) in incremental angular steps through 90° for performing 360° of scanning of the surface of the bulk meat product (2). The stepper motor (47) rotates the carrier (43) through 90° in the direction of the arrow B, and then in the reverse direction of arrow C and so on so that the bulk meat product is scanned at intervals along its length as the carrier (43) is oscillated in the direction of the arrows B and C through 90°.

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"A method and apparatus for determining the
topographical surface shape of an article"

The present invention relates to a method and apparatus for
determining the topographical surface shape of an article, and in
5   particular though not limited to a bulk meat product.

Meat production, in general, requires the butchering of meat into
selected cuts for retail sales. The meat may be in the form of a
large joint, a side, a half side, a quarter side or the like.
Such large portions of meat will hereinafter referred to as bulk
10 meat products. The meat cuts which are butchered from the bulk
meat product for retail sales may be joint portions, steaks,
sliced cuts, for example, rashers and the like. It is desirable
that the yield from such bulk meat products should be maximised
when preparing the cuts therefrom. Wastage should be minimised.
15 In addition, customer requirements in terms of aesthetics of the
cut must also be taken into account when preparing a bulk meat
product for butchering, so that the shape, feel and quality of the
resultant meat cuts is in accordance with customer requirements.
Furthermore, in general, it is desirable that meat cuts when cut
20 from a bulk meat product, should be of a predetermined weight.

It is common in the meat processing industry to subject bulk meat
products to pressing and shaping prior to butchering, so that the
cuts butchered from the bulk meat product will be of a desired
shape, and in particular, the cuts can be more easily butchered
25 from the bulk meat product to be a predetermined weight. Such
pressure and shaping of bulk meat products can, if overpressing
takes place, lead to damage to the meat, and in particular, to
muscle tissue in the meat. This, in general, results in
fragmentation of the meat when butchered into the meat cuts. It
30 is therefore desirable to ensure overpressing of a bulk meat
product does not occur. This, thus, requires a determination of
the topographical surface shape of the bulk meat product prior to
pressing. Additionally, in order that meat cuts can be butchered

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from the bulk meat product of predetermined weight, the
determination of the topographical surface shape of a bulk meat
product is also required.

The present invention is directed towards providing a method and
5   apparatus for determining the topographical surface shape of a
bulk meat product, and indeed any article.

According to the invention, there is provided a method for
determining the topographical surface shape of an article, wherein
the method comprises the steps of
10   determining the length of the article in a first direction
by a length determining means, and storing the length,
          scanning the surface of the article through 360°
transversely of the first direction at a plurality of intervals
along the length of the article in the first direction for
15   determining the cross-sectional shape of the article at the
respective intervals,
          storing the scanned data,
          determining the topographical surface shape of the article
from the stored length and the stored scanned data.

20   In one embodiment of the invention the weight of the article is
determined.

In another embodiment of the invention the volume of the article
is computed from the stored scanned data and the stored length.

In a further embodiment of the invention the average density of
25   the article is computed from the volume and weight of the article
so that the width of a slice of the article can be determined for
producing a slice of the article of a predetermined weight.

In another embodiment of the invention the width of the slice the
weight of which is to be of predetermined weight is determined in
30   a direction parallel to the first direction.

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Preferably, the scanning of the article is carried out by a
scanning means mounted on a carrier means, the carrier means
defining a rotational axis extending in the first direction.

Advantageously, the method comprises moving one of the carrier
5   means and the article in a first angular direction about the
rotational axis for causing the scanning means to scan 360° of the
surface of the article, and moving the said one of the carrier
means and the article in a second angular direction opposite to
the first angular direction about the rotational axis, for causing
10   the scanning means to scan 360° of the surface of the article at
the next interval.

Preferably, the carrier means is angularly moved relative to the
article.

In one embodiment of the invention at least two scanning means are
15   provided on the carrier means equi-spaced apart circumferentially
about the rotational axis, the method comprising the step of
moving the carrier means in the first angular direction through an
angle similar to the angular spacing between adjacent scanning
means so that each scanning means scans the surface of the article
20   through an angle similar to the angular spacing between adjacent
scanning means.

In another embodiment of the invention four scanning means are
provided at 90° intervals about the rotational axis of the carrier
means.

25   In one embodiment of the invention the scanning means and the
article is moved linearly in the first direction for scanning the
article at the intervals along the length of the article.

In a further embodiment of the invention the article is moved in
the first direction relative to the scanning means.

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In a still further embodiment of the invention the article is
moved continuously as the scanning means is scanning.

Ideally, the article is moved at a constant speed through the
scanning means.

5   Additionally, the invention provides a method for determining the
topographical surface shape of a bulk meat product, wherein the
method comprises the steps of
          determining the length of the bulk meat product in a first
direction by a length determining means, and storing the length,
10   scanning the surface of the bulk meat product through 360°
transversely of the first direction at a plurality of intervals
along the length of the bulk meat product in the first direction
for determining the cross-sectional shape of the bulk meat product
at the respective intervals,
15   storing the scanned data,
          determining the topographical surface shape of the bulk meat
product from the stored length and the stored scanned data.

In one embodiment of the invention the weight of the bulk meat
product is determined.

20   In another embodiment of the invention the volume of the bulk meat
product is computed from the stored scanned data and the stored
length.

In a further embodiment of the invention the average density of
the bulk meat product is computed from the volume and weight of
25   the bulk meat product so that the width of a slice of the bulk
meat product can be determined for producing a slice of the bulk
meat product of a predetermined weight.

In another embodiment of the invention the width of the slice the
weight of which is to be of predetermined weight is determined in
30   a direction parallel to the first direction.

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Preferably, the scanning of the bulk meat product is carried out
by a scanning means mounted on a carrier means, the carrier means
defining a rotational axis extending in the first direction.

Advantageously, the method comprises moving one of the carrier
5   means and the bulk meat product in a first angular direction about
the rotational axis for causing the scanning means to scan 360° of
the surface of the bulk meat product, and moving the said one of
the carrier means and the bulk meat product in a second angular
direction opposite to the first angular direction about the
10   rotational axis, for causing the scanning means to scan 360° of
the surface of the bulk meat product at the next interval.

Preferably, the carrier means is angularly moved relative to the
bulk meat product.

In one embodiment of the invention at least two scanning means are
15   provided on the carrier means equi-spaced apart circumferentially
about the rotational axis, the method comprising the step of
moving the carrier means in the first angular direction through an
angle similar to the angular spacing between adjacent scanning
means so that each scanning means scans the surface of the bulk
20   meat product through an angle similar to the angular spacing
between adjacent scanning means.

In another embodiment of the invention four scanning means are
provided at 90° intervals about the rotational axis of the carrier
means.

25   In one embodiment of the invention the scanning means and the bulk
meat product is moved linearly in the first direction for scanning
the bulk meat product at the intervals along the length of the
bulk meat product.

In a further embodiment of the invention the bulk meat product is
30   moved in the first direction relative to the scanning means.

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In a still further embodiment of the invention the bulk meat
product is moved continuously as the scanning means is scanning.

Ideally, the bulk meat product is moved at a constant speed
through the scanning means.

5   Additionally, the invention provides apparatus for determining the
topographical surface shape of an article, wherein the apparatus
comprises
        a length determining means for determining the length of the
article in a first direction,
10   a scanning means for scanning the surface of the article
through 360° transversely of the first direction at a plurality of
intervals along the length of the article in the first direction
for determining the cross-sectional shape of the article at the
respective intervals,
15   a storing means for storing scanned data from the scanning
means and the length of the article from the length determining
means, and
        a computing means for computing the topographical surface
shape from the stored length and the stored scanned data.

20   In one embodiment of the invention a weighing means is provided
for weighing the article, and the weight determined by the
weighing means is stored in the storing means.

In another embodiment of the invention the computing means
computes the volume of the article from the stored length and the
25   stored scanned data.

In a further embodiment of the invention the computing means
computes the average density of the article from the computed
volume and the stored weight of the article.

Ideally, the scanning means is mounted on a carrier means, the
30   carrier means defining a rotational axis extending in a first

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direction, the carrier means being movable in a first angular
direction about the rotational axis for causing the scanning means
to scan 360° of the surface of the article through 360° and the
carrier means being movable in a second angular direction opposite
5   the first angular direction for causing the scanning means to scan
360° of the surface of the article at the next interval along the
length of the article in the first direction.

In one embodiment of the invention the carrier means accommodates
the article axially therethrough so that as the carrier means is
10   being moved in the first and second angular directions the
scanning means traces a locus which encircles the article.

In another embodiment of the invention the scanning means
comprises at least one scanning head mounted on the carrier means.

Preferably, the scanning means comprises at least two scanning
15   heads mounted on the carrier means and equi-spaced
circumferentially around the rotational axis defined by the
carrier means, the carrier means being movable in the first and
second angular directions through respective angles similar to the
angular spacing between adjacent scanning heads.

20   In one embodiment of the invention the scanning means comprises
four scanning heads located at 90° intervals around the rotational
axis of the carrier means, and the carrier means is movable
through an angle of 90° in the first and second angular
directions.

25   Ideally, a means for rotating the carrier means in the respective
first and second angular directions is provided.

Preferably, the means for rotating the carrier means comprises a
constant speed motor or a stepper motor.

In a further embodiment of the invention a carrier monitoring

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means is provided for monitoring the movement of the carrier means
as the carrier means is being moved in the first and second
angular directions during scanning by the scanning means so that
"X" and "Y" co-ordinates of respective points on the surface of
5   the article scanned by the scanning means can be determined.

In one embodiment of the invention a throughfeed conveying means
is provided for conveying the article through the scanning means.

In another embodiment of the invention the throughfeed conveying
means is a constant speed conveying means.

10   Preferably, the throughfeed conveying means comprises an upstream
conveying means and a downstream conveying means, the respective
upstream and downstream conveying means being spaced apart to
define a scanning gap for accommodating scanning of the article as
the article is being passed from the upstream conveying means to
15   the downstream conveying means across the scanning gap.

In one embodiment of the invention an infeed conveying means is
provided for conveying the article to the throughfeed conveying
means.

In another embodiment of the invention the length detecting means
20   comprises a sensing means for detecting the respective opposite
ends in the first direction of the article, and a conveyor
monitoring means for monitoring the distance travelled by the
infeed conveying means, between the times the scanning means
detects the respective opposite ends of the article for
25   determining the length of the article.

In one embodiment of the invention a counting means is provided
for counting pulses from the monitoring means for determining the
distance travelled by the infeed conveying means, the counting
means being responsive to the sensing means detecting the leading
30   end of the article for commencing counting of the pulses, and to

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the sensing means detecting the trailing end of the article for
ceasing the count, the counting means communicating with the
computing means for computing the length of the article.

In a further embodiment of the invention the sensing means
5   comprises a photosensor sensing means.

In one embodiment of the invention, the apparatus is suitable for
determining the topographical surface shape of a bulk meat
product.

The invention will be more clearly understood from the following
10   description of a preferred embodiment thereof which is given by
way of example only, with reference to the accompanying drawings,
in which:

        Fig. 1 is a schematic side elevational view of apparatus
        according to the invention for determining the topographical
15   surface shape of a bulk meat product.

        Fig. 2 is a schematic end elevational view of a portion of
        the apparatus of Fig. 1 in the direction of the arrow X of
        Fig. 1, and

        Fig. 3 is a block representation of a control circuit for
20   controlling the apparatus of Fig. 1.

Referring to the drawings, there is illustrated apparatus
according to the invention indicated generally by the reference
numeral 1 for determining the topographical surface shape of an
article, in this case a bulk meat product. Two bulk meat products
25   indicated by the reference numeral 2 are illustrated on the
apparatus 1. The apparatus 1 comprises a main framework, which
for ease of illustration and understanding of the invention is not
shown, but which extends from an upstream end 4 of the apparatus 1
to a downstream end 5 of the apparatus 1. Typically, bulk meat

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products are fed to the upstream end 4 of the apparatus 1 on a
supply conveyor (not shown), and preferably, the bulk meat
products 2 should be supplied spaced apart on the supply conveyor
(not shown). A main conveying means for conveying the bulk meat
5   products 2 through the apparatus 1 in a first linear direction,
namely, in the direction of the arrow A comprises three belt
conveyors, namely, an infeed conveyor 7, a weighing conveyor 9 and
a throughfeed conveyor 10. The infeed conveyor 7 is located at
the upstream end 4 of the apparatus 1 for receiving the bulk meat
10   products 2 from the supply conveyor (not shown). The weighing
conveyor 9 is provided for weighing the individual bulk meat
products 2, and is located downstream of the infeed conveyor 7,
and is aligned therewith and adjacent thereto for receiving the
bulk meat products 2 for weighing. The throughfeed conveyor 10
15   which is aligned with and adjacent to the weighing conveyor 9
receives the bulk meat products 2 from the weighing conveyor 9 for
conveying the bulk meat products 2 through a scanning means,
namely, a scanning device 11 through which the bulk meat products
2 are conveyed as will be described in more detail below. The
20   throughfeed conveyor 10 is formed by a pair of conveyors, namely,
an upstream conveyor 14 which receives the bulk meat products 2
from the weighing conveyor 9, and a downstream conveyor 15. The
upstream and downstream conveyors 14 and 15, respectively, are
aligned with each other but spaced apart to form a scanning gap 17
25   for facilitating 360° scanning of the bulk meat products 2 by the
scanning device 11 as the respective bulk meat products 2 are
passed across the scanning gap 17. The scanned bulk meat products
2 are discharged from the downstream conveyor 15, typically onto a
take-away conveyor (not shown). The conveyors 7, 9, 10, 14 and 15
30   are all mounted on the main framework (not shown).

The apparatus 1 is operated under the control of a control circuit
18 which is described in more detail below and is housed in a
control box 19. An infeed conveyor drive means comprising an
electrically powered infeed drive motor 20 is mounted on the main
35   framework (not shown) and drives the infeed conveyor 7 under the

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control of the control circuit 18 through a chain/sprocket drive
transmission 21. A weighing conveyor drive means comprising an
electrically powered drive motor 23 drives the weighing conveyor 9
under the control of the control circuit 18. The drive motor 23
5   is mounted in a subframework 24 of the weighing conveyor 9, and
drives the weighing conveyor 9 through a chain/sprocket drive
transmission 25. The upstream and downstream conveyors 14 and 15
are each driven by corresponding throughfeed drive means, namely,
electrically powered drive motors 28 and 29, which are mounted on
10   the main framework (not shown). The drive motors 28 and 29 are
constant speed drive motors for driving the respective upstream
and downstream conveyors 14 and 15, respectively, at the same
constant speed under the control of the control circuit 18.
Chain/sprocket drive transmissions 30 transfer drive from the
15   drive motors 28 and 29 to the respective upstream and downstream
conveyors 14 and 15.

A length determining means is provided in conjunction with the
infeed conveyor 7 for determining the length of each bulk meat
product 2 in the first direction, namely, in the direction of the
20   arrow A from a leading end 32 to a trailing end 33 of the bulk
meat products 2. The length determining means comprises a
conveyor monitoring means, namely, an encoder 35 which is coupled
to a drive shaft 36 of the infeed conveyor 7, which is driven by
the drive transmission 21, for determining the angular rotation of
25   the drive shaft 36, for in turn determining the distance travelled
by the infeed conveyor 7. A photosensor 37 located above the
infeed conveyor 7 detects the respective leading and trailing ends
32 and 33, respectively, of each bulk meat product 2. A counter
38, see Fig. 3, is provided for counting pulses from the encoder
30   35 which correspond to the angular rotation of the drive shaft 36.
The control circuit 18 reads the number of pulses counted by the
counter 38 from the time the photosensor 17 detects the leading
end 32 until the photosensor 37 detects the trailing end 33 of
each bulk meat product 2. In this way, the control circuit 18 as
35   will be described below determines the length of the bulk meat

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product 2.

A weighing means, namely, a load cell 40 mounted on the main
framework (not shown) supports the weighing conveyor 9 and the
subframework 24 for weighing each bulk meat product 2 on the
5   weighing conveyor 9. The drive motor 23 under the control of the
control circuit 18 is momentarily stopped for stopping the
weighing conveyor 9 when each bulk meat product 2 is supported on
the weighing conveyor 9 for facilitating accurate weighing of the
bulk meat products 2.

10   The scanning device 11 is arranged for scanning the surface of
each bulk meat product 2 through 360° transversely of the
direction of movement of the bulk meat products 2 in the direction
of the arrow A at predetermined intervals as the bulk meat product
2 is passed through the scanning device 11. Signals from the
15   scanning device 11 are fed to the control circuit which computes
and stores particulars of the transverse cross-sectional area and
the transverse cross-sectional shape of the bulk meat products 2
at the predetermined intervals. This data on the transverse
cross-sectional area and the transverse cross-sectional shape of
20   each bulk meat product 2 combined with the length of the bulk meat
product 2 between its leading and trailing ends 32 and 33,
respectively, permits the topographical surface shape of the bulk
meat product 2 to be determined.

The scanning device 11 comprises a carrier means, namely, a hoop
25   shaped carrier 43 which extends around the throughfeed conveyor 10
and defines a rotational axis 44 which extends in the direction of
the arrow A. The carrier 43 is mounted in the main framework (not
shown) for rotation about the rotational axis 44. Four ultrasonic
scanning heads 45 for scanning the surface of each bulk meat
30   product 2 are mounted on the carrier 43, and are located at equi-
spaced intervals circumferentially around the carrier 43, namely,
at 90° intervals to each other. The scanning heads 45 are
arranged to direct their scanning beams inwardly at the bulk meat

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product 2 on the throughfeed conveyor 10 offset from each other
for avoiding interscanning head interference, this can most
clearly be seen in Fig. 2.

A drive means, namely, a stepper motor 47 mounted on the main
5   framework (not shown) rotates the carrier 43 in a first angular
direction, namely, in the direction of the arrow B through 90°, so
that each scanning head 45 scans 90° of the surface of the bulk
meat product 2 as it is passing through the carrier 43, thereby
providing a scan of 360° of the surface of the bulk meat product
10   2. The stepper motor 47 also rotates the carrier 43 in a second
angular direction, namely, in the direction of the arrow C,
opposite to the first angular direction through 90° for carrying
out a second scan by each scanning head 45 through 90°, thereby
providing a second 360° scan of the surface of the bulk meat
15   product 2. Accordingly, the stepper motor 47 under the control of
the control circuit 18 continuously oscillates the carrier 43
about the rotational axis 44 as each bulk meat product 2 is being
passed through the carrier 43. Thus, the surface of the bulk meat
product 2 is scanned through 360° at intervals as the bulk meat
20   product 2 is passed through the carrier 43, each interval
corresponding to one 90° rotation of the carrier 43. In this way,
the control circuit 18 can be determined by "X" and "Y" co-ordinates
from the scanned data, coupled with the control signal issued to
the stepper motor 47 "X" and "Y" co-ordinates in the plane of the
25   carrier 43 of a plurality of points around the circumferential
surface of the bulk meat product 2 scanned by the scanning device
11. The "Z" co-ordinate of each point in the direction of the
arrow A is determined from the stored length of the bulk meat
product 2 and the speed at which the upstream and downstream
30   conveyors 14 and 15 are driven by their respective drive motors 28
and 29.

Turning now to the control circuit 18, the control circuit 18
comprises a microprocessor 50 which controls the circuit 18, and
the apparatus 1. The drive motor 20 of the infeed conveyor 7 is

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operated under the control of the microprocessor 50 through a
driver 51. The photosensor 37 comprises a light source, namely, a
laser light source 52 which is operated under the control of the
microprocessor 50 through a driver 53. A sensor 54 in the
5   photosensor 37 is sensitive to laser light from the light source
52 reflected by the bulk meat product 2. Signals from the sensor
54 are fed through an analogue to digital converter 55 and are
read by the microprocessor 50. The encoder 35 which monitors the
angular rotation of the drive shaft 36 of the infeed conveyor 7
10   outputs a pulse at predetermined angular intervals of rotation of
the drive shaft 36, which may be as low as 5° intervals of
rotation. The pulses are fed through an analogue to digital
converter 56 to the counter 38. The counter 38 is operated under
the control of the microprocessor 18 for counting the number of
15   pulses outputted by the sensor 54 from the time the photosensor 37
detects the leading end 32 until the trailing end 35 of the bulk
meat product 2 has been detected, for in turn determining the
length of the bulk meat product 2 which is computed by a computing
means provided by software in the control circuit microprocessor
20   50. The computed length of the bulk meat product 2 is stored in a
random access memory (RAM) 57.

The drive motor 23 of the weighing conveyor 9 is operated under
the control of the microprocessor 50 through a driver 58, and as
discussed above, when each bulk meat product 2 is fully supported
25   by the weighing conveyor 9, the drive motor 23 is momentarily
stopped for facilitating weighing of the bulk meat product 2 by
the load cell 40. Signals from the load cell 40 are fed back to
the microprocessor 50 through an analogue to digital converter 59,
and the computing means provided by software in the microprocessor
30   50 computes the weight of the bulk meat product 2 from signals
received from the load cell 40. The computed weight is stored in
the RAM 57.

The motors 28 and 29 of the upstream and downstream conveyors 14
and 15 are operated under the control of the microprocessor 50 by

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drivers 60 and 61, respectively. The stepper motor 47 is operated
under the control of the microprocessor 50 through a driver 63.
The signals from the scanning heads 45 are fed to the
microprocessor 50 through analogue to digital converters 65 to 68.
5   The microprocessor 50 operates the stepper motor 47 to rotate the
carrier 43 in incremental angular steps, typically of 5°
intervals. Each time the carrier 43 is stopped, signals from the
scanning heads 45 are read by the microprocessor 50. The
computing means provided by suitable software in the
10   microprocessor 50 computes the "X" and "Y" co-ordinates in the
plane of the carrier 43 of the four points around the surface of
the bulk meat product 2 from the signals from the scanning heads
45 knowing the angular positions of the scanning heads 45 around
the rotational axis 44 of the carrier 43. The angular positions
15   of the scanning heads 45 is determined by the software from the
number of angular increments by which the carrier 43 has been
rotated in each 90° cycle. Such software will be well known to
those skilled in the art. The "Z" co-ordinate of each point is
determined from the stored length "L" of the bulk meat product 2
20   and from the speed at which the upstream and downstream conveyors
14 and 15 are being driven. At the end of scanning of the bulk
meat product 2, the computing means provided by the suitable
software in the microprocessor 50 then computes the transverse
cross-sectional area and the transverse cross-sectional shape of
25   the bulk meat product 2 at the respective intervals. From this,
and the "Z" co-ordinates of the respective points on the surface
of the bulk meat product 2, the entire shape of the bulk meat
product 2 can be determined, as can its volume. A three
dimensional image of the bulk meat product 2 can then be prepared
30   by suitable software in the microprocessor 50. The density of the
bulk meat product 2 is computed by dividing the weight of the bulk
meat product 2 by the volume of the bulk meat product 2.

The volume, weight, density and three dimensional image of the
bulk meat product 2 is then stored in the RAM 57, and may be fed
35   out from the microprocessor 50 on a parallel port 69 for use by

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other meat processing apparatus. For example, the stored data on
each bulk meat product 2 can be fed to apparatus for preparing
cuts of meat so that the bulk meat product 2 can be sliced to
provide slices of predetermined weight. From the stored data, the
5   butchering apparatus would be able to determine the width of each
slice to provide a slice of a predetermined weight. Additionally,
the stored data may be fed to a pressing and shaping apparatus if
the bulk meat product is to be subsequently pressed and shaped.
The stored data would allow the pressing and shaping of the bulk
10 meat product to be controlled to avoid overpressing.

In use, bulk meat products 2 are sequentially fed from a supply
conveyor (not shown) or other suitable supply means to the infeed
conveyor 7. As each bulk meat product 2 passes along the infeed
conveyor 7, the length of the bulk meat product 2 from its leading
15 end 32 to its trailing end 33 is determined from signals received
by the control circuit 18 from the photosensor 37 and the encoder
35. The length of the respective bulk meat products 2 is stored
in the RAM 57. The bulk meat products 2 are sequentially
transferred from the infeed conveyor 7 to the weighing conveyor 9
20 where the weight of each bulk meat product 2 is determined by the
load cell 40 under the control of the control circuit 18. The
weight of the respective bulk meat products 2 is stored in the RAM
57.

25 The bulk meat products 2 are then transferred from the weighing
conveyor 9 to the upstream conveyor 14 of the throughfeed conveyor
10 and in turn passed through the scanning device 11 onto the
downstream conveyor 14. Operation of the scanning device 11 is
commenced as the scanning heads 45 detect the leading end 32 of
30 the bulk meat product 2, and operation of the scanning device 11
is terminated by detection of the trailing end 33 of the bulk meat
product 2 by the scanning heads 45. The scanning device
determines the transverse cross-sectional area and transverse
cross-sectional shape of the bulk meat products 2 at predetermined
35 intervals as the bulk meat products 2 are being passed through the

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carrier 43, and signals from the scanning heads and the angular
position of the carrier 43 determined from the stepper motor 47
are stored in the RAM 57, where they are subsequently used for
computing the transverse cross-sectional area and transverse
5   cross-sectional shape of the bulk meat product 2. The density,
volume and overall shape of the bulk meat product 2 are then
computed and stored in the RAM 57 for outputting through a
parallel port 69 of the microprocessor 50 to other meat processing
apparatus to which the bulk meat product 2 is to be transferred.

10   While the scanning heads have been described as being ultrasonic
scanning heads, the scanning heads could be laser scanners, or any
other suitable scanners.

While the apparatus and method have been described for determining
the topographical surface shape, volume average density and
15   transverse cross-sectional area of a bulk meat product, the method
and apparatus may be used for determining these parameters of any
article.

The advantages of the invention are many. A particularly
important advantage of the invention is that it provides
20   relatively simple and straightforward apparatus and method for
determining the volume, average density and topographical shape of
a bulk meat product or any other article.

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CLAIMS

1.   A method for determining the topographical surface shape of
an article (2), characterised in that the method comprises the
steps of
5   determining the length of the article (2) in a first
direction (A) by a length determining means (35,37), and storing
the length,
         scanning the surface of the article (2) through 360°
transversely of the first direction (A) at a plurality of
10   intervals along the length of the article (2) in the first
direction for determining the cross-sectional shape of the article
(2) at the respective intervals,
         storing the scanned data,
         determining the topographical surface shape of the article
15   (2) from the stored length and the stored scanned data.

2.   A method as claimed in Claim 1 characterised in that the
weight of the article (2) is determined.

3.   A method as claimed in Claim 1 or 2 characterised in that
the volume of the article (2) is computed from the stored scanned
20   data and the stored length.

4.   A method as claimed in Claim 3 characterised in that the
average density of the article (2) is computed from the volume and
weight of the article so that the width of a slice of the article
can be determined for producing a slice of the article of a
25   predetermined weight.

5.   A method as claimed in Claim 4 characterised in that the
width of the slice the weight of which is to be of predetermined
weight is determined in a direction parallel to the first
direction (A).

30   6.   A method as claimed in any preceding claim characterised in
that the scanning of the article is carried out by a scanning

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means (45) mounted on a carrier means (43), the carrier means (43)
defining a rotational axis (44) extending in the first direction.

7.   A method as claimed in Claim 6 characterised in that the
method comprises moving one of the carrier means (43) and the
5   article (2) in a first angular direction (B) about the rotational
axis (44) for causing the scanning means (45) to scan 360° of the
surface of the article, and moving the said one of the carrier
means (43) and the article (2) in a second angular direction (C)
opposite to the first angular direction (B) about the rotational
10   axis (44), for causing the scanning means (45) to scan 360° of the
surface of the article at the next interval.

8.   A method as claimed in Claim 6 or 7 characterised in that
the carrier means (43) is angularly moved relative to the article.

9.   A method as claimed in any of Claims 6 to 8 characterised in
15   that at least two scanning means (45) are provided on the carrier
means (31) equi-spaced apart circumferentially about the
rotational axis (44), the method comprising the step of moving the
carrier means (43) in the first angular direction (B) through an
angle similar to the angular spacing between adjacent scanning
20   means (45) so that each scanning means (45) scans the surface of
the article (2) through an angle similar to the angular spacing
between adjacent scanning means (45).

10.   A method as claimed in Claim 9 characterised in that four
scanning means (45) are provided at 90° intervals about the
25   rotational axis (44) of the carrier means (31).

11.   A method as claimed in any preceding claim characterised in
that one of the scanning means and the article is moved linearly
in the first direction for scanning the article at the intervals
along the length of the article.

30   12.   A method as claimed in Claim 11 characterised in that the

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article (2) is moved in the first direction (A) relative to the
scanning means (45).

13.   A method as claimed in Claim 12 characterised in that the
article (2) is moved continuously as the scanning means (45) is
5   scanning.

14.   A method as claimed in Claim 13 characterised in that the
article (2) is moved at a constant speed through the scanning
means (45).

15.   A method for determining the topographical surface shape of
10   a bulk meat product (2), characterised in that the method
comprises the steps of
        determining the length of the bulk meat product (2) in a
first direction (A) by a length determining means (35,37), and
storing the length,
15   scanning the surface of the bulk meat product (2) through
360° transversely of the first direction (A) at a plurality of
intervals along the length of the bulk meat product (2) in the
first direction for determining the cross-sectional shape of the
bulk meat product (2) at the respective intervals,
20   storing the scanned data,
        determining the topographical surface shape of the bulk meat
product (2) from the stored length and the stored scanned data.

16.   A method as claimed in Claim 15 characterised in that the
weight of the bulk meat product (2) is determined.

25   17.   A method as claimed in Claim 15 or 16 characterised in that
the volume of the bulk meat product (2) is computed from the
stored scanned data and the stored length.

18.   A method as claimed in Claim 17 characterised in that the
average density of the bulk meat product (2) is computed from the
30   volume and weight of the bulk meat product so that the width of a

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slice of the bulk meat product can be determined for producing a
slice of the bulk meat product of a predetermined weight.

19.   A method as claimed in Claim 18 characterised in that the
width of the slice the weight of which is to be of predetermined
5   weight is determined in a direction parallel to the first
direction (A).

20.   A method as claimed in any of Claims 15 to 19 characterised
in that the scanning of the bulk meat product is carried out by a
scanning means (45) mounted on a carrier means(43), the carrier
10   means (43) defining a rotational axis (44) extending in the first
direction.

21.   A method as claimed in Claim 20 characterised in that the
method comprises moving one of the carrier means (43) and the bulk
meat product (2) in a first angular direction (B) about the
15   rotational axis (44) for causing the scanning means (45) to scan
360° of the surface of the bulk meat product, and moving the said
one of the carrier means (43) and the bulk meat product (2) in a
second angular direction (C) opposite to the first angular
direction (B) about the rotational axis (44), for causing the
20   scanning means (45) to scan 360° of the surface of the bulk meat
product at the next interval.

22.   A method as claimed in Claim 20 or 21 characterised in that
the carrier means (43) is angularly moved relative to the bulk
meat product.

25   23.   A method as claimed in any of Claims 20 to 22 characterised
in that at least two scanning means (45) are provided on the
carrier means (31) equi-spaced apart circumferentially about the
rotational axis (44), the method comprising the step of moving the
carrier means (43) in the first angular direction (B) through an
30   angle similar to the angular spacing between adjacent scanning
means (45) so that each scanning means (45) scans the surface of

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the bulk meat product (2) through an angle similar to the angular
spacing between adjacent scanning means (45).

24.   A method as claimed in Claim 23 characterised in that four
scanning means (45) are provided at 90° intervals about the
5   rotational axis (44) of the carrier means (31).

25.   A method as claimed in any of Claims 15 to 24 characterised
in that one of the scanning means and the bulk meat product is
moved linearly in the first direction for scanning the bulk meat
product at the intervals along the length of the bulk meat
10   product.

26.   A method as claimed in Claim 25 characterised in that the
bulk meat product (2) is moved in the first direction (A) relative
to the scanning means (45).

27.   A method as claimed in Claim 26 characterised in that the
15   bulk meat product (2) is moved continuously as the scanning means
(45) is scanning.

28.   A method as claimed in Claim 27 characterised in that the
bulk meat product (2) is moved at a constant speed through the
scanning means (45).

20   29.   Apparatus for determining the topographical surface shape of
an article (2), characterised in that the apparatus comprises
        a length determining means (35,37) for determining the
length of the article in a first direction (A),
        a scanning means (45) for scanning the surface of the
25   article through 360° transversely of the first direction at a
plurality of intervals along the length of the article in the
first direction for determining the cross-sectional shape of the
article at the respective intervals,
        a storing means (57) for storing scanned data from the
30   scanning means and the length of the article (2) from the length

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determining means, and

a computing means (50) for computing the topographical
surface shape from the stored length and the stored scanned data.

30.   Apparatus as claimed in Claim 29 characterised in that a
5   weighing means (40) is provided for weighing the article, and the
weight determined by the weighing means (40) is stored in the
storing means (57).

31.   Apparatus as claimed in Claim 29 or 30 characterised in that
the computing means (50) computes the volume of the article (4)
10   from the stored length and the stored scanned data.

32.   Apparatus as claimed in Claim 31 characterised in that the
computing means (50) computes the average density of the article
from the computed volume and the stored weight of the article.

33.   Apparatus as claimed in any of Claims 29 to 32 characterised
15   in that the scanning means (45) is mounted on a carrier means
(43), the carrier means (31) defining a rotational axis (44)
extending in a first direction (A), the carrier means (43) being
movable in a first angular direction (B) about the rotational axis
(44) for causing the scanning means (45) to scan 360° of the
20   surface of the article through 360° and the carrier means (43)
being movable in a second angular direction (C) opposite the first
angular direction for causing the scanning means (45) to scan 360°
of the surface of the article at the next interval along the
length of the article in the first direction.

25   34.   Apparatus as claimed in Claim 33 characterised in that the
carrier means (43) accommodates the article axially therethrough
so that as the carrier means (43) is being moved in the first and
second angular directions the scanning means (45) traces a locus
which encircles the article.

30   35.   Apparatus as claimed in Claim 33 or 34 characterised in that

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the scanning means (45) comprises at least one scanning head (45) mounted on the carrier means (43).

36.   Apparatus as claimed in any of Claims 33 to 35 characterised in that the scanning means (45) comprises at least two scanning heads (45) mounted on the carrier means (43) and equi-spaced circumferentially around the rotational axis (44) defined by the carrier means (43), the carrier means (43) being movable in the first and second angular directions through respective angles similar to the angular spacing between adjacent scanning heads.

37.   Apparatus as claimed in Claim 36 characterised in that the scanning means (45) comprises four scanning heads (45) located at 90° intervals around the rotational axis (44) of the carrier means (43), and the carrier means (43) is movable through an angle of 90° in the first and second angular directions.

38.   Apparatus as claimed in any of Claims 33 to 37 characterised in that a means (47) for rotating the carrier means (43) in the respective first and second angular directions is provided.

39.   Apparatus as claimed in Claim 38 characterised in that the means (47) for rotating the carrier means comprises a constant speed motor (47) or a stepper motor.

40.   Apparatus as claimed in any of Claims 33 to 39 characterised in that a carrier monitoring means (47) is provided for monitoring the movement of the carrier means as the carrier means (43) is being moved in the first and second angular directions during scanning by the scanning means (45) so that "X" and "Y" co-ordinates of respective points on the surface of the article scanned by the scanning means can be determined.

41.   Apparatus as claimed in any of Claims 29 to 40 characterised in that a throughfeed conveying means (10) is provided for conveying the article through the scanning means.

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42. Apparatus as claimed in Claim 41 characterised in that the
throughfeed conveying means (10) is a constant speed conveying
means.

43. Apparatus as claimed in Claim 41 or 42 characterised in that
5   the throughfeed conveying means (10) comprises an upstream
conveying means (14) and a downstream conveying means (15), the
respective upstream and downstream conveying means (14,15) being
spaced apart to define a scanning gap (17) for accommodating
scanning of the article as the article is being passed from the
10   upstream conveying means (14) to the downstream conveying means
(15) across the scanning gap (17).

44. Apparatus as claimed in any of Claims 41 to 43
characterised in that an infeed conveying means (7) is provided
for conveying the article to the throughfeed conveying means (10).

15   45. Apparatus as claimed in Claim 44 characterised in that the
length detecting means (35,37) comprises a sensing means (37) for
detecting the respective opposite ends (32,33) in the first
direction of the article (2), and a conveyor monitoring (35) means
for monitoring the distance travelled by the infeed conveying
20   means (7), between the times the scanning means (37) detects the
respective opposite ends (32,33) of the article (2) for
determining the length of the article.

46. Apparatus as claimed in Claim 45 characterised in that a
counting means (38) is provided for counting pulses from the
25   monitoring means (35) for determining the distance travelled by
the infeed conveying means (7), the counting means (38) being
responsive to the sensing means (37) detecting the leading end
(32) of the article (2) for commencing counting of the pulses, and
to the sensing means (37) detecting the trailing end (33) of the
30   article for ceasing the count, the counting means (38)
communicating with the computing means (50) for computing the

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length of the article.

47. Apparatus as claimed in Claim 46 characterised in that the sensing means (37) comprises a photosensor sensing means (37).

48. Apparatus as claimed in any of Claims 29 to 47 characterised in that the apparatus is adapted for determining the topographical surface shape of a bulk meat product.
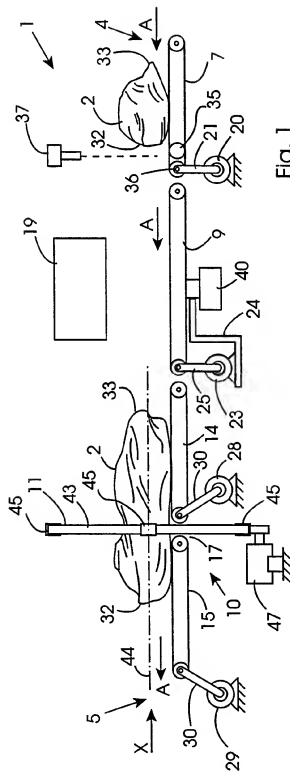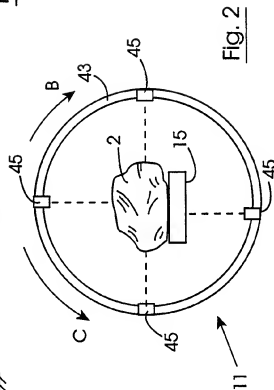
Fig. 1

Fig. 2

Fig. 3

INTERNATIONAL SEARCH REPORT
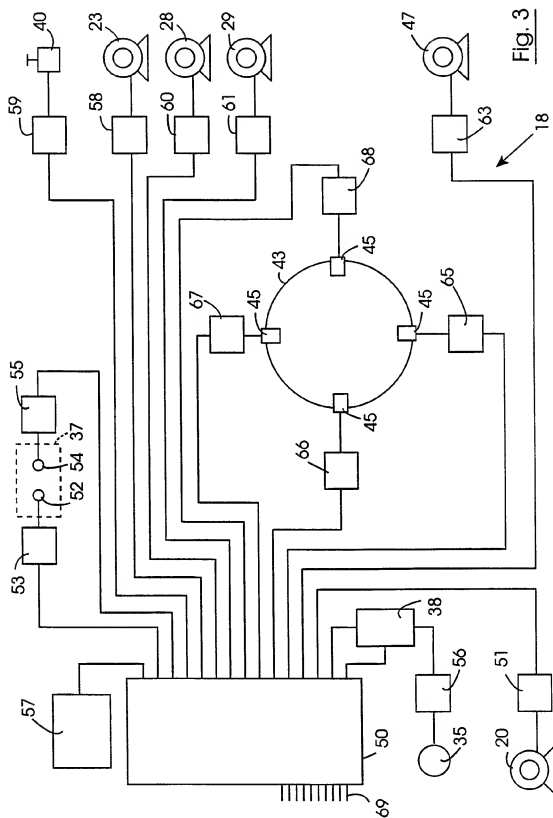
A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   G01B17/00   G01B17/06

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6   G01B   A22C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate. of the relevant passages	Relevant to claim No.
X	DE 44 18 036 A (SIEMENS AG) 30 November 1995 see column 3 – column 4; figures 1-5	1,15,29, 41
Y		3,6,8, 17,20, 22,31,48

Y	EP 0 429 711 A (FRISCO-FINDUS AG) 5 June 1991 see page 3 – page 4; figures 1,2	3,17,31, 48
A		2,5,16, 18,19, 30,32

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| X | Further documents are listed in the continuation of box C. | | X | Patent family members are listed in annex. |

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Date of the actual completion of theinternational search	Date of mailing of the international search report
26 October 1998	30/10/1998

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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A	see page 3 - page 5; figures 1-4	1,7,9, 10,15, 21,23, 29,33, 35,36
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page 2 of 2

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